Amendments to the Specification

Please replace the following paragraphs:

[0003] In radio frequency integrated circuits, it is often desirable for the input and output connections to be differential. An example of a differential connection is two wires having an equal impedance to a common ground conductor, their respective signals 180 degrees out of phase. A transmission line having these characteristics is known as a *balanced* line, as opposed to an *unbalanced* line. The advantages of a balanced radio frequency signal input over an unbalanced input include higher dynamic range, higher bandwidth, and lower pick-up and generation of interference.

[0012] FIG. 1B illustrates a classic prior art Marchand balun.

[0015] FIG. 3 illustrates a coplanar waveguide implantation of the classic prior art Marchand balun.

[0036] Referring to FIG. 1A, an example system implementing this invention is illustrated. A data signal122 from a satellite 124 is received at a dish antenna 126 and routed to a low noise block 120. Typically, low noise block 120 comprises a low noise amplifier, a mixer, an oscillator and an IF amplifier. Low noise block 120 amplifies and converts data signal 122 to a desired frequency range from data signal 122 downlink frequency. In one embodiment the desired frequency range is 950-2150 MHz. Data signal 122 is passed over

a coaxial cable 132 from low noise block 120 to a television set-top box 134. Set-top box 134 comprises a tuner circuit_138 that converts data signal 122 into a signal suitable for reception by a television 136. An example commercial embodiment of tuner 138 is the Broadcom BCM3440A0.

[0039] One suitable structure is the Marchand balun 100, shown in FIG. 1B. This classic balun implementation uses two quarter-wavelength ($\lambda/4$) sections of coaxial cable inside another coaxial shield. One section includes electromagnetically coupled lines 104 and 108, and the other section includes electromagnetically coupled lines 102 and 106. The electromagnetic coupling between coaxial line 102 and 106 and between 104 and 108 results in a signal at balun output 112 that is equal in amplitude and opposite in phase to a signal at balun output 114 relative to an input signal at balun input 110.

[0059] Referring to FIG. 5B, an embodiment of a balun ~~501~~ 500 is presented with calculated element values and metal trace dimensions. Balun ~~501~~ 500 has the following electrical characteristics:

[0066] FIG. 8 illustrates an apparatus 800 for transferring direct current power and low frequency digital control signals to low noise block 120 (see Fig. 1A) adapted for use with balun 500 (see Fig. 5A). Direct current power is defined as power supplied from a current source as direct current or from a voltage source as direct voltage. In addition to direct current power, low frequency digital control signals can be supplied to low noise block 120. A direct current power and low frequency digital control signal source 802 is coupled to

spiral inductor 810. Direct current power and low frequency digital control signals can be supplied from source 802 together or either signal separately. Spiral inductor 810 is connected to balun radio frequency input 702, approximately 425 mils from balun input 110. Radio frequency input 702 is connected to coaxial cable 132 (see Fig. 1A). Coaxial cable 132 is connected to low noise block 120. A capacitor 804 is also coupled to ground 512 and to radio frequency input 702 approximately 425 mils from balun input 110. Capacitor 804 and inherent capacitance from the connection of spiral inductor 810 reduce undesirable cross over interference at balun input 110. Ground 512 is provided from vias 220. Individual vias are shown as solid dots but, for clarity, each is not labeled..

[0069] A loading capacitor 922 is coupled to transmission lines 902 and 904 and to ground 512. Loading capacitor 922 is equivalent to capacitor 530 (see Fig. 5A). Capacitor 922 can be fabricated as a distributed or a lumped element capacitor. A tuning capacitor 926 is coupled across the outputs of capacitor 914 and capacitor 916. Capacitor 926 provides a differential capacitance on balun 900 to allow finer tuning of the internal balun impedance and thereby reduce input return loss. Ground 512 is provided from vias 220. Individual vias are shown as solid dots but, for clarity, each is not labeled.

[0072] FIG. 10 also illustrates an embodiment of a device used to provide direct current and voltage power or low frequency digital control signals to low noise block 120 (see Fig. 1A). Direct current power and low frequency digital control signal source 802 is coupled to meandered trace 1025. Trace 1025 is coupled to balun 1000 between input 110 and input

capacitor 912. Meandered trace 1025 provides a high impedance to data signal122 to minimize undesired electrical loading of balun 1000 and low noise block 120.

[0073] FIG. 11 illustrates an alternate embodiment of a spiral inductor used to transfer direct current power and low frequency digital control signals to coaxial cable 132 (see Fig. 1A). Spiral inductor 1100 has direct current power and low frequency digital control signal source 802. A connection 1120 couples spiral 1100 to balun input 110. Ground 512 is provided from vias 220. Individual vias are shown as solid dots but, for clarity, each is not labeled. Ground 512 is also located under the spiral elements. For clarity the ground under spiral inductor 1100 is not illustrated with diagonal lines. The top layer ground 512 is shown with diagonal lines.

[0074] The high impedance exhibited by inductor 1100 does not effect the operation of balun 500 (see Fig. 5A) or coaxial cable 132 at signal ~~122~~ frequencies of 950 to 2150 MHZ. Direct current power and low frequency digital control signals are unaffected by the high impedance. The direct current power and low frequency digital control signals are placed on the center connector of coaxial cable 132 and applied to low noise block 120. Inductor 1100 is an embodiment of inductor 800 modified to function with ground under the metal traces. Spiral inductor 1100 can be used in place of meandered trace 1025 for coupling direct current power and low frequency digital control signal source 802 to balun input 110.

[0075] FIG. 12 illustrates a method 1200 for initial design of a balun according to the present invention. In step 1210, a design for the balun is selected. In step 1220, the

performance of the balun is simulated. In step 1230, the performance of the balun is compared with the design goal performance. If the simulated performance is equal or better than design goal performance (YES), the initial design is complete, step 1250. If simulated performance is less than design goal performance the existing parameters are varied (NO), step 1240. Then step 1220 is performed again to simulate the balun performance. Steps 1220, 1230 and 1240 continue until the initial balun design is complete in step 1250.

[0079] FIG. 16 illustrates the method 1600 of final balun design. Step 1250 occurs after the balun initial design is complete. In step 1620, the actual load impedance is encoded in the balun simulator. In step 1640, an impedance matching network is coupled to the balun input. In step 1650, an impedance matching network is coupled to each side of the balun differential output. In step 1660, the balun performance is simulated. In step 1670, the balun simulated performance is compared with design goal performance. If simulated is equal or greater than design goal performance (YES), step 1690 is performed. In step 1690, balun design is completed. If simulated performance is less than a design goal (NO), step 1680 is performed. In step 1680, the value of an element in the input and output matching networks is varied incrementally in a manner to result in balun performance closer to the design goal. Then step 1660 is performed. Steps 1660, 1670, and 1680 are performed in sequence until simulated balun performance is equal to or better than design goal performance.